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The effect of telerehabilitation on early outcomes in patients undergoing primary total knee replacement: A prospective randomized study

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Ethics Committee Approval
It was approved by the ethics committee of the University of Health Sciences, Kanuni Sultan Suleyman Training and Research Hospital. File number: 2019/06/146
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Abstract

Background/Aim: The continuity of rehabilitation is a problem after arthroplasty operations. There is a need for accessible rehabilitation programs for patients. The purpose of this study is to determine the difference in knee functions and patients' quality of life between patients doing home telerehabilitation and home rehabilitation after total knee arthroplasty (TKA).
Methods: This prospective study was conducted on 90 patients, between June 2019 and January 2021. Patients are divided into three groups. Patients in group 1 are told to continue with the daily routine exercises which began in hospital. Group 2 patients got an information message to their mobile phones every day for the first month, reminding them of their postoperative exercises, whereas patients in group 3 are called by mobile phone for the same reminding. All patients participating in the study were evaluated by completing the Universities of Western Ontario and McMaster Osteoarthritis Index (WOMAC) scores, the Knee Society Clinical Evaluation System (KSS), the Barthel Index (BI) and the Quality of Life Scale Short Form 36 (SF-36) preoperatively and in the first and third months postoperatively, and the differences between the groups based on these scores were evaluated.
Results: There was a statistically significant difference in WOMAC between the groups regarding first-month and third-month postoperatively (P=0.004 and P<0.001, respectively), as well as in KSS values between the same groups (P=0.048 and P=0.036, respectively). There was no statistically significant difference between the groups regarding postoperative first-month BI (P=0.826) and SF-36 values (P=0.264). There was a statistically significant difference between the groups regarding postoperative third-month BI and SF-36 values (P=0.035 and P<0.001, respectively).
Conclusion: The telerehabilitation therapy appears to be more effective and successful than the control group, as shown by improvements in overall physical functions.

Keywords: Total knee arthroplasty, Telerehabilitation, Knee society score, WOMAC, Barthel index, SF-36

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Introduction

Osteoarthritis (OA) is the most prevalent form of joint disease in elderly worldwide, and knees are the most commonly affected joints. One of the leading causes of disability, OA has a severe social impact and adverse effects on public health [1]. About 10% of men and 13% of women over the age of 60 present with symptoms of knee OA. The proportion of the population with symptomatic knee OA is expected to increase due to general ageing and obesity. There has been a steady increase in the number of total knee arthroplasties performed over the past few years, along with shorter hospital stays and earlier return home [2].

Total knee arthroplasty (TKA) is an effective surgical procedure in patients with severe knee OA. It is typically performed in elderly patients to correct a deformity of the knee joint, increase function, maintain mobility and reduce pain. The procedure involves replacing injured bone as well as cartilage with a prosthesis [3]. As a very stable and predictable procedure, TKA is successful in more than 90% of patients after 10 years after surgery [4]. Physical rehabilitation is an important factor in the recovery of patients after TKA. Rehabilitation usually begins in the hospital and continues after discharge, both as outpatient and at home [5, 6]. Physical rehabilitation is essential to achieve successful results following TKA. Preferably, it should be initiated preoperatively and continued for several months postoperatively [7]. For effective management of post-TKA rehabilitation, outcome measures, including patient range of motion, scar conditions, joint inflammation, and detailed and complex knee functions are the basis for assessing the needs of patients undergoing rehabilitation, developing a personalized therapy plan, and re-evaluating the condition and post-therapy development [8]. Currently, rehabilitation optimizes postoperative physical activity and increases the clinical and social benefits resulting from surgery. Access to this rehabilitation can be difficult for many patients after TKA, especially for those living in rural or remote areas. The distance and associated travel costs, funding limitations and lack of health care providers in these communities limit health care availability [9]. One possible solution is to use telerehabilitation technology to enable remote delivery of rehabilitation care [10].

A growing body of literature supports the use of telerehabilitation to improve patient satisfaction and health outcomes for various clinical conditions such as neurological diseases [11, 12], stroke [13], cancer [14], and cardiac and pulmonary rehabilitation [15]. Compared to face-to-face rehabilitation, remote services by phone or internet are more affordable and accessible, especially for people living in rural areas [16].

Home telerehabilitation is defined as rehabilitation services provided at home from a remote location through a telecommunications system and information technology [17]. This innovative way of delivering rehabilitation services has been the source of increased interest in the healthcare community, mainly because of its potential to reduce costs, improve access to services, and increase the efficiency of providing rehabilitation services to the community. Some studies have indeed shown that telerehabilitation after TKA is effective [10, 18, 19].

The efficacy of subsequent rehabilitation for patients after knee replacement has been well established [20, 21]. However, its mid-and long-term sustainability remains a significant challenge for maintaining therapeutic success. Exercise therapy is required for this purpose after rehabilitation [20, 22], but recent data [23] suggest that only half of the patients continue with the recommended aftercare options. Reasons for this may be a lack of reconciliation with job demands and long trips to facilities that offer treatment. More flexible and individualized treatment options are needed to increase the sustainability of postoperative exercise therapy [23]. Telerehabilitation may have the potential to increase access to treatment in structurally weak areas where appropriate healthcare structures and supplies are deficient. In addition, telerehabilitation can be performed at any time, and can therefore increase patients' compliance, especially in working patients. There is growing evidence that orthopedic telerehabilitation has positive effects on a variety of clinical conditions. Previous research has shown that telerehabilitation interventions after knee replacement are not inferior to face-to-face interventions [9, 18, 19, 24].

The purpose of this study is to determine the difference of home telerehabilitation and home rehabilitation in knee functions and rehabilitation on patients' quality of life after TKA.

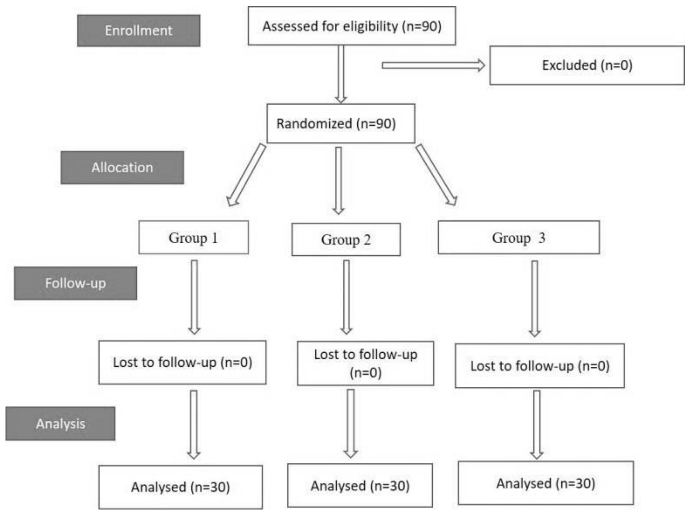
Materials and methods

The Institutional Review Board and Ethics Committee of the University of Health Sciences, Kanuni Sultan Suleyman Training and Research Hospital approved this prospective study (2019.06.146). The study was conducted on patients who underwent surgery for primary knee OA. Excluded from the study were the following:

- Patients who develop OA secondary to rheumatologic disease.
- Patients with OA knee contracture before surgery.
- Patients with traumatic OA.
- Patients with hip OA that may affect functional results or who were operated for this reason.
- Patients with lumbar pathology that may affect functional results.
- Patients with vascular pathologies in the lower extremities.
- Patients who underwent arthroplasty that cut the posterior cruciate ligament.

The flowchart of the study is shown in figure 1.

Figure 1: Flow chart



Knee arthroplasty protecting the posterior cruciate ligament was applied to all patients. All operations were carried out under the supervision of the senior operator/author (C.E.). The isometric exercise programme was started in all patients on the first postoperative day, and patients were mobilized with the help of a walker next day. On the following days, quadriceps strengthening exercises were started. All movement and mobilization of patients were performed by a physiotherapist with 10 years of professional experience.

Uncomplicated patients who could exercise in postoperative follow-up were randomly divided into three groups. Randomization of the patients was carried out online with the help of a computer program. The number of patients required to achieve statistical significance was determined by power analysis. With an alpha of 0.05 and a power of 80%, 28 patients per group were needed. Taking into account the possibility of deficiencies in patient follow-up, each group was formed from thirty patients.

- Group 1: patients are told to continue with the daily routine exercises which began before discharge.
- Group 2: patients got an information message to their mobile phones every day for the first month, reminding them of their postoperative exercises.
- Group 3: patients are called by mobile phone at the same time every day for one month after surgery to remind and inform them about their exercises.

All patients participating in the study were evaluated by completing the Universities of Western Ontario and McMaster Osteoarthritis Index (WOMAC) scores, the Knee Society Clinical Evaluation System (KSS), the Barthel Index (BI) and the Quality of Life Scale Short Form 36 (SF-36) preoperatively and in the postoperative first and third months. The differences of these scores between the groups were evaluated.

The primary measurement tool for the study was WOMAC, which measures the participant-reported effect of OA on pain, stiffness, and disability [25]. WOMAC is a valid, reliable and responsive self-reporting assessment recommended for use in patients with lower extremity OA [25].

KSS consists of two parts: 1) the knee score, which evaluates the knee joint only, and 2) the functional score, which evaluates the patient's ability to walk and climb stairs [26]. As a result of the dual score, misleading low knee score is prevented due to reasons not related to knee such as ageing or weakness. In this evaluation system, pain, stability and range of motion are determined, and points are reduced for flexion contracture, hyperextension and malalignment, if present. With this system, even mild and painless anteroposterior and mediolateral instability scored 100 points, only if knees are in proper alignment, with 125 degrees of motion range. Walking distance and using stairs were evaluated for a functional score. Points were reduced if a walking aid (crutches, walker, etc.) was used. The highest functional score was 100, indicating that the patient could walk without distance restriction and use the stairs easily [26].

BI was developed to assess disability in patients with neuromuscular and musculoskeletal disorders undergoing rehabilitation and was recommended for routine use in the assessment of the elderly by the Royal College of Physicians [27]. The index is an ordinal scale that includes ten activities of daily living. The BI is scored in five-points increments, with a maximum total of 100 points.

SF-36 is a self-assessment scale consisting of 36 items providing the measurement of eight dimensions. The dimensions include physical function, social function, role limitations due to physical problems and emotional issues, mental health, energy/vitality, pain and general perception of health [28]. Subscales evaluate health between 0-100 points; a score of 0 indicates poor health, while a score of 100 indicates good health [28].

Statistical analysis

While evaluating the findings obtained in the study, the IBM Statistical Package for the Social Sciences (SPSS) 22 (IBM SPSS, Turkey) programme was used for statistical analysis. While reviewing the study data, the conformity of the parameters to the normal distribution was evaluated with the Shapiro Wilks test. In addition to descriptive statistical methods (mean, standard deviation, frequency), the one-way analysis of variance (ANOVA) was used to compare the normally distributed parameters in the quantitative data. The Tukey HDS test and Tamhane's T2 test were used to identify the group that caused the difference. ANOVA with Repetitive Measurements was used for within-group comparisons of normally distributed parameters, and the Bonferroni test was used to determine the period causing the difference. Significance was evaluated by $P<0.05$.

Results

This study was conducted on 90 patients, in three groups of 30 patients each, between June 2019 and January 2021. The mean age of the participants was 66.8 (51-79). The operated knee was right and left knee in 39 (43.3%) and 51 (56.7%) patients, respectively. Patients in group 1 were followed up with routine physiotherapy, whereas patients in group 2 were reminded of their exercises with daily text messages, and group 3 patients were reminded of their physiotherapy with daily phone calls.

There was no statistically significant difference between the groups regarding preoperative WOMAC values ($P>0.05$). There was a statistically significant difference between the groups regarding first-month WOMAC values ($P=0.004$). As a result of pairwise comparisons, the first-month WOMAC values for Group 1 were statistically significantly lower than Group 3 ($P=0.002$). There was no statistically significant difference between the other groups regarding WOMAC values ($P>0.05$). There was a statistically significant difference between the groups regarding the third-month WOMAC values ($P<0.001$). As a result of the pairwise comparisons, the third-month WOMAC values for Group 1 were statistically significantly lower than Group 2 and Group 3 (P:0.047 and $P<0.001$, respectively). The third-month WOMAC values for Group 2 were statistically significantly lower than Group 3 ($P=0.035$) (table 1).

Table 1: Evaluation of WOMAC levels between and within groups

WOMAC	Group 1 (Min-Max) (Mean(SD))	Group 2 (Min-Max) (Mean(SD))	Group 3 (Min-Max) (Mean(SD))	Total (Min-Max) (Mean(SD))	¹P-value
Preop	(73-86) (82.2(2.94))	(74-88) (82.43(2.91))	(74-89) (82.37(2.85))	(73-89) (80.31(4.33))	0.950
1st month	(64-78) (31.57(2.86))	(63-79) (29.87(4.33))	(65-80) (27.97(4.67))	(63-80) (70.2(4.25))	0.004*
3rd month	(9-20) (18.1(2.94))	(9-20) (15.9(3.85))	(10-19) (13.07(4.56))	(9-20) (13.67(2.87))	<0.001*
²P-value	<0.001*	<0.001*	<0.001*		
Preop-1st month ³P-value	<0.001*	<0.001*	<0.001*		
Preop-3rd month ³P-value	<0.001*	<0.001*	<0.001*		
1st month-3rd month ³P-value	<0.001*	<0.001*	<0.001*		

¹ Analysis of Variance in Repeated Measurements, ² Friedman Test, ³ Bonferroni Test, * $P<0.05$

There was no statistically significant difference between the groups regarding preoperative KSS values ($P>0.05$). There was a statistically significant difference between the groups regarding first and third month KSS values ($P=0.048$ and $P=0.036$, respectively). As a result of the pairwise comparisons, the first-month KSS values for Group 2 were statistically significantly lower than Group 3 ($P=0.037$). There was no statistically significant difference between the other groups regarding KSS values ($P>0.05$). As a result of the pairwise comparisons, the third-month KSS values for Group 2 were statistically significantly lower than Group 3 ($P=0.034$). There was no statistically significant difference between the other groups regarding KSS values ($P>0.05$) (table 2).

Table 2: Evaluation of KSS levels between and within groups

KSS	Group 1 (Min-Max) (Mean(SD))	Group 2 (Min-Max) (Mean(SD))	Group 3 (Min-Max) (Mean(SD))	Total (Min-Max) (Mean(SD))	¹P-value
Preop	(15-38) (25.17(5.57))	(14-37) (26.4(5.33))	(12-35) (24.6(5.12))	(12-38) (24.72(5.52))	0.163
1st month	(77-98) (84.63(5.25))	(74-96) (83.13(5.17))	(74-96) (86.33(4.37))	(74-98) (84.7(5.06))	0.048*
3rd month	(79-99) (86.7(4.88))	(80-99) (85.9(4.82))	(83-99) (88.83(3.6))	(79-99) (87.14(4.59))	0.036*
²P-value	<0.001*	<0.001*	<0.001*		
Preop-1st month ³P-value	<0.001*	<0.001*	<0.001*		
Preop-3rd month ³P-value	<0.001*	<0.001*	<0.001*		
1st month-3rd month ³P-value	<0.001*	<0.001*	<0.001*		

¹ Analysis of Variance in Repeated Measurements, ² Friedman Test, ³ Bonferroni Test, * $P<0.05$

There was no statistically significant difference between the groups regarding preoperative and postoperative first-month BI values ($P>0.05$). There was a statistically significant difference between the groups regarding postoperative third-month BI values ($P=0.035$). As a result of the pairwise comparisons, the postoperative third-month BI values for Group 2 were statistically significantly lower than Group 3 ($P=0.029$). There was no statistically significant difference between the other groups regarding the postoperative third-month BI values ($P>0.05$) (table 3).

There was no statistically significant difference between the groups regarding preoperative and postoperative first-month SF-36 values (physical function, social function, role limitations due to physical problems, role limitations due to emotional issues, mental health, energy/vitality, pain and general perception of health) ($P>0.05$). There was a statistically significant difference between the groups regarding postoperative third-month SF-36 values ($P<0.001$). As a result of the pairwise comparisons, third-month SF-36 values of Group 1 were statistically significantly lower than Group 3 ($P<0.001$). There was no statistically significant difference between the other groups regarding postoperative third-month SF-36 values ($P>0.05$) (table 4).

Table 3: Evaluation of BI levels between and within groups

Barthel index	Group 1 (Min-Max) (Mean(SD))	Group 2 (Min-Max) (Mean(SD))	Group 3 (Min-Max) (Mean(SD))	Total (Min-Max) (Mean(SD))	¹P-value
Preop	(81-96) (88.6(3.86))	(80-95) (87.17(4.04))	(81-95) (88.3(3.83))	(80-96) (88.02(3.91))	0.330
Postop 1st month	(50-62) (55.97(3.1))	(51-62) (56.2(3.11))	(51-63) (56.47(3.19))	(50-63) (56.21(3.11))	0.826
Postop 3rd month	(93-99) (95.9(1.67))	(90-99) (95.43(2.19))	(92-99) (96.77(2.06))	(90-99) (96.03(2.04))	0.035*
²P-value	<0.001*	<0.001*	<0.001*		
Preop-1st month ³P-value	<0.001*	<0.001*	<0.001*		
Preop-3rd month ³P-value	<0.001*	<0.001*	<0.001*		
1st month-3rd month ³P-value	<0.001*	<0.001*	<0.001*		

¹ Analysis of Variance in Repeated Measurements, ² Friedman Test, ³ Bonferroni Test, * $P<0.05$

Table 4: Evaluation of SF-36 levels between and within groups

SF-36	Group 1 (Min-Max) (Mean(SD))	Group 2 (Min-Max) (Mean(SD))	Group 3 (Min-Max) (Mean(SD))	Total (Min-Max) (Mean(SD))	¹P-value
Preop	(25-46) (36.07(5.72))	(26-46) (35.43(4.46))	(26-44) (35.9(4.11))	(25-46) (35.8(4.77))	0.870
Postop 1st month	(50-77) (61.33(6.4))	(52-72) (62.47(5.04))	(52-80) (63.77(5.69))	(50-80) (62.52(5.76))	0.264
Postop 3rd month	(72-90) (80.67(4.49))	(75-92) (83.3(4.34))	(74-94) (85.87(4.98))	(72-94) (83.28(0.03))	<0.001*
²P-value	<0.001*	<0.001*	<0.001*		
Preop-1st month ³P-value	<0.001*	<0.001*	<0.001*		
Preop-3rd month ³P-value	<0.001*	<0.001*	<0.001*		
1st month-3rd month ³P-value	<0.001*	<0.001*	<0.001*		

¹ Analysis of Variance in Repeated Measurements, ² Friedman Test, ³ Bonferroni Test, * $P<0.05$

Discussion

The primary finding of this study was that the patients' scores of knee function and general survival rehabilitated by telephone every day were better than the patients who underwent self-rehabilitation at home. The sustainability of maintaining the therapeutic success of rehabilitation programmes remains a significant challenge. Treatment options after rehabilitation are often remote and difficult to access. Therefore, as telerehabilitation promises to increase patient access, to improve quality of healthcare and to reduce costs, it may have the potential to increase access to treatment in structurally weak areas where appropriate healthcare structures and supplies are deficient. The telerehabilitation appears to be a promising proposition for improving patients' motor function, especially after orthopedic surgery [28, 29]. It may be beneficial for moving longer distances and coping with the challenges of daily life.

It is well known that the compliance of patients exercising at home should be improved, and the flexible use of telerehabilitation can improve compliance [29]. The reason for patient's non-adherence to the programme includes the lack of positive feedback and a degree of experienced helplessness [30]. Solutions to this problem may be setting targets, monitoring and receiving feedback using telerehabilitation systems [31].

Kauppila et al. [32] compared telerehabilitation versus inpatient rehabilitation, even after early hospital discharge. They noted that when telerehabilitation and inpatient rehabilitation outcomes following primary total hip or knee replacement were compared using validated outcome measures, there was no difference in clinical outcomes at 3 and 12 months postoperatively. Both treatment groups achieved improvement in pain and function similar to other studies [33, 34]. Because we obtained similar results in this study, we believe patients may need a combination of inpatient and outpatient rehabilitation to meet their needs and preferences at each stage of the continuing rehabilitation process.

In a non-randomized Australian study, Tribe et al. [35] compared the functional outcomes of patients who received home rehabilitation and inpatient rehabilitation after total hip and knee replacement for primary OA. There was not any difference in functional outcomes at one-year follow-up.

In light of the suggestion that telerehabilitation therapy can increase the therapeutic relationship, patient motivation, and patient and family involvement in rehabilitation, it can be assumed that telerehabilitation will also improve performance and outcomes [36, 37]. Coordinating the rehabilitation process across disciplines and increasing patient engagement can help improve the consistency and quality. The findings suggest that telerehabilitation programmes are at least as effective as inpatient postoperative rehabilitation programmes in achieving functional outcomes. In terms of future research directions, determining the optimal setting for community rehabilitation and the impact of that setting on results are key priority. It is also a key in optimizing treatment and diversifying resources for people who need it most.

This study has several limitations. The patient numbers in groups in the study were limited, and there is a need to study on a larger population. A limited follow-up period of three months has implications for interpreting results because the long-term effects of this rehabilitation programme are unknown. Therefore, future research should use long follow-up periods to define the long-term impacts of this alternative form of service delivery better.

The absence of a fourth group receiving inpatient rehabilitation is another limitation in this study. In addition, the inability to compare the costs of traditional rehabilitation programmes with the rehabilitation used in this study is another drawback. Future research should also include economic analyses to evaluate the financial impact of remote physical therapy. Such analyses are critical as healthcare providers are unlikely to implement telerehabilitation without clear evidence of its financial viability and sustainability.

Conclusion

Our study shows that telerehabilitation therapy appears to be more effective and successful than the control group, as evidenced by improvements in overall physical functions. As teletherapy is feasible and acceptable for clinicians and patients, the next step will be to conduct controlled trials to compare the cost-benefit of two treatment alternatives: telerehabilitation and inpatient rehabilitation.

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